Wireless MAC Processor technical Overview

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What is the Wireless MAC Processor

The WMP is a special-purpose processor deviced to execute MAC programs. It permits a clear decoupling between protocol logic and the platform. The MAC logic is designed and implemented by the programmer using the MAC programming language. The instruction set and the MAC engine pre-developed by the vendor.

MAC Programming Language

eXtended Finite State Machine - XFSM
It is a convenient and compact way to represent the MAC protocol behavior.

Instruction set

ACTIONS - frame management, radio control, time scheduling
TX frame, set PHY params, RX frame, set timer, freeze counter, build header, forge frame, switch channel, etc
EVENTS - available HW/SW signals/interrupts
Busy channel signal, RX indication, inqueued frame, end timer, etc
CONDITIONS - boolean/arithmetic tests on available registers/info
Frame address == X, queue length >0, ACK received, power level < P, etc

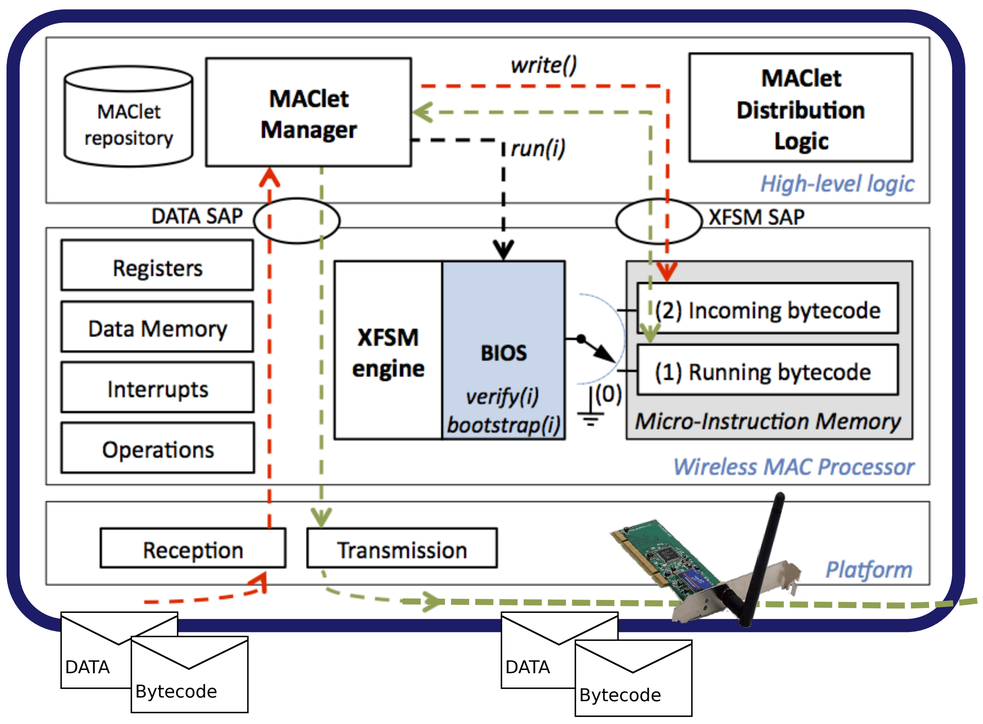
MAC Engine

The MAC Engine is a specialized XFSM executor.

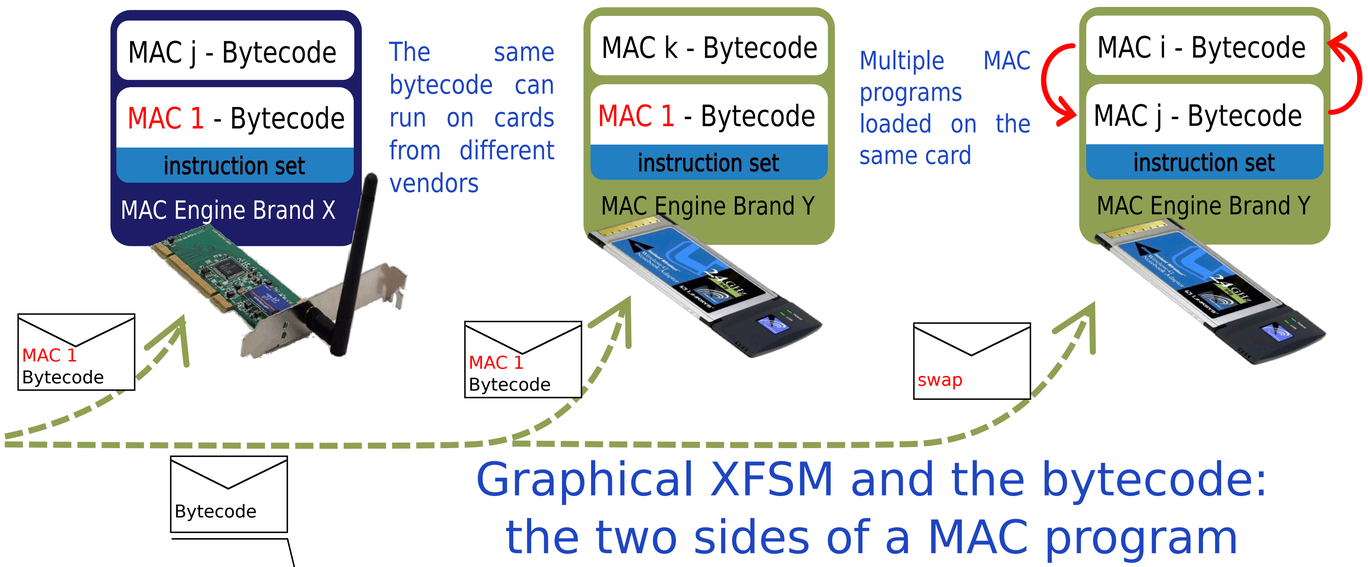
It is integrated in the Wireless Card and handles NIC resources in real-time

closed implementation (manufacturer specific) - open API

WMP architecture and code mobility



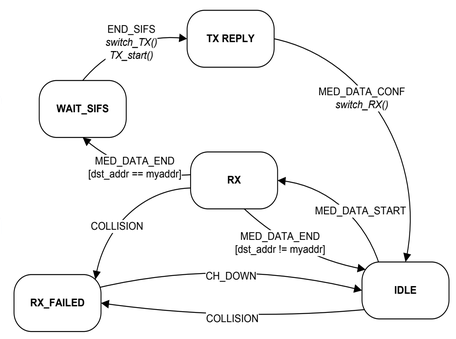
The WMP architecture permits the design MAC once, run everywhere paradigm and the decoupling between the platform and the MAC protocol logic.



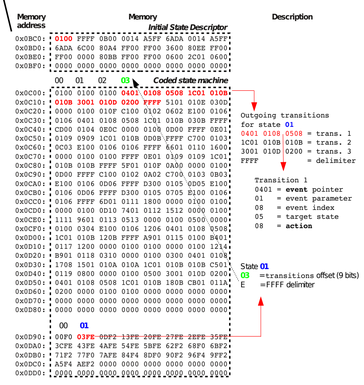
Graphical XFSM and the bytecode: the two sides of a MAC program

Graphical XFSM

- human-readeable and easy to develop;
- uses actions, conditions and events of the instruction set as basic building blocks;
- the WMP-compiler translates the XFSM in bytecode.



Bytecode

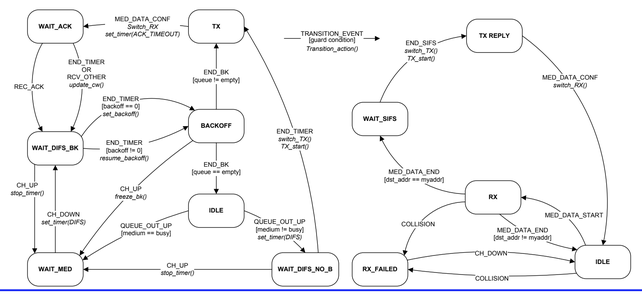


- very slim, only 544 bytes for DCF. It is sent via a regular wireless frame;
- can be dynamically loaded 'on the fly';
- is portable over different vendors' WMPs (as long as the instruction set is the same).
- can be periodically scheduled;
- can be injected locally or on a remote NIC sending it over the wireless link.

MAC program examples

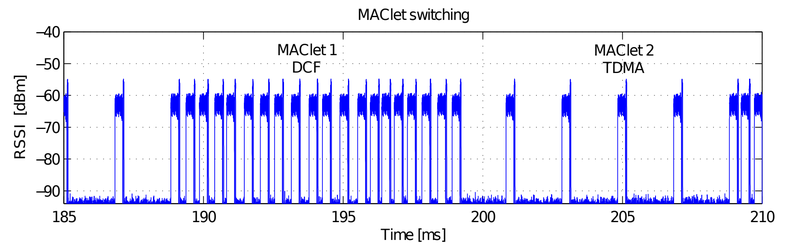
DCF

Even standard DCF can be defined on the top of our API.

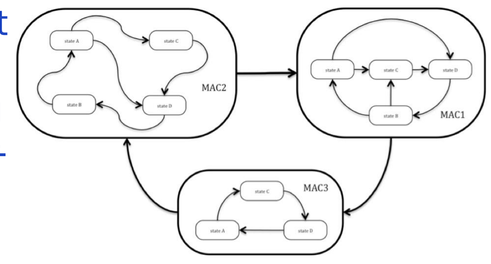


DCF running on the WMP has the same performances than the hard-coded firmware implementation. DCF timing parameters can be finely tuned.

Bytecode switching

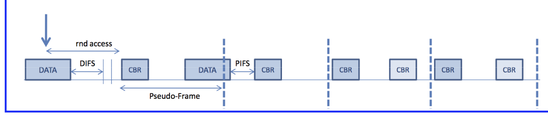


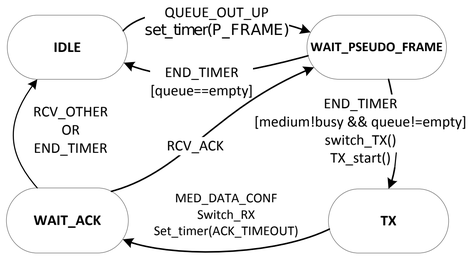
A MAC switch is just a state transition. Bytecode switching is performed at per-packet time resolution.

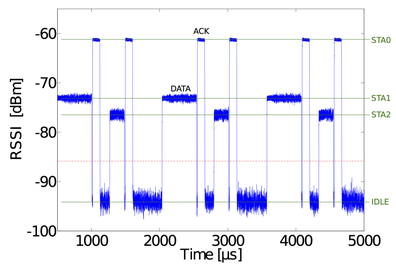


Pseudo-TDMA

A simple pseudo-TDMA is performed after a random access.

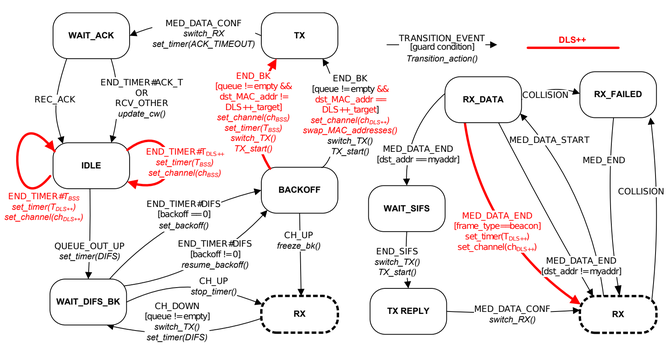


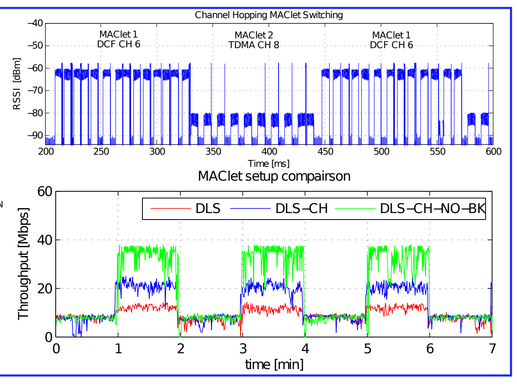




DLS++

Direct Link Setup with multi-channel capabilities. Use legacy DCF towards the AP and TDMA on a different channel while communicating on a direct link.





Links

I. Tinnirello, G. Bianchi, P. Gallo, D. Garlisi, F. Giuliano, F. Gringoli, “Wireless MAC Processors: Programming MAC Protocols on Commodity Hardware” IEEE INFOCOM, March 2012.

http://wmp.tti.unipa.it

http://www.ict-flavia.eu/